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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/020,314	12/18/2001	Yasuhiro Shimamoto	HITA.0143	8410

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EXAMINER	
NGUYEN, KHIEM D	

ART UNIT	PAPER NUMBER
2823	

DATE MAILED: 03/23/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/020,314	SHIMAMOTO ET AL.	
	Examiner	Art Unit	
	Khiem D. Nguyen	2823	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *06 January 2005*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1,3-8,10-16 and 18-32* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1,3-8,10-16 and 18-32* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *18 December 2001* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

New Grounds of Rejection

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claims 1, 3, 16, 18, 19, 21, 22, 31 and 32 are rejected under 35 U.S.C. 102(e) as being anticipated by Marsh et al. (U.S. Patent 6,461,909).

In re claim 1, Marsh discloses a fabricating method of a semiconductor integrated circuit device 106 comprising forming a bottom electrode 118 (col. 10, lines 39-62) of a capacitor with high-k material on a semiconductor substrate 110 by a chemical vapor deposition method in a sub-atmospheric pressure using an organoruthenium compound as a precursor (col. 7, lines 50-67 and FIG. 8), which includes steps of:

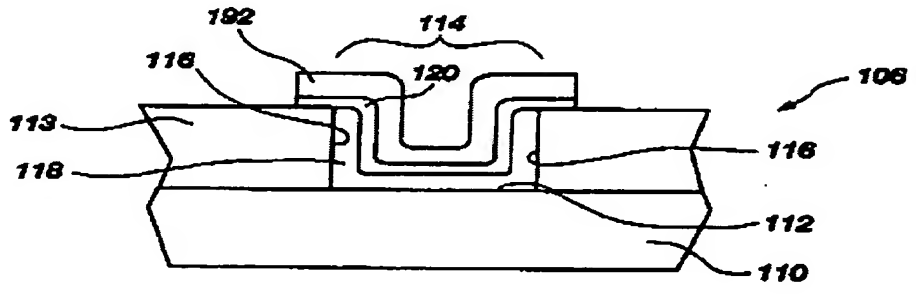

Fig. 8

providing the semiconductor substrate 110 in a deposition chamber;

increasing a temperature of the semiconductor substrate 110 in the chamber up to a desired temperature (col. 7, lines 50-60);

separately supplying the precursor and an oxidation gas into the deposition chamber to form a ruthenium film for the bottom electrode with a desired thickness on the heated semiconductor substrate, the oxidation gas being separately supplied to the deposition chamber by a supplying system different from a precursor supplying system and only during when the precursor being supplied (col. 7, line 50 to col. 8, line 61); and

stopping the supply of the precursor and the oxidation gas and decreasing the temperature of the semiconductor substrate, wherein the bottom electrode essentially consists of ruthenium (col. 8, lines 23-46).

In re claims 3 and 19, Marsh discloses wherein the ruthenium electrode forming method further includes a step of introducing a balance gas in addition to a carrier gas (Ar) so as to keep a pressure in the deposition chamber constant through all of the other steps (col. 8, lines 23-40).

In re claim 16, Marsh discloses wherein the electrode of ruthenium of a capacitor with high-k material is formed on the semiconductor substrate, and immediately thereafter annealing is performed at not less than the formation temperature of the bottom electrode of ruthenium in an inert atmosphere or a reducing atmosphere thereby inhibiting deformation of crystal grains of the bottom electrode of ruthenium in the annealing step during or after capacitor insulator formation (col. 8, lines 23-40).

In re claim 18, Marsh discloses wherein the oxidation gas comprises at least one of O_2, N_2O, H_2O, NO_2, and O_3 (col. 2, line 61 to col. 3, line 5).

In re claim 21, Marsh discloses a fabricating method of a semiconductor integrated circuit device 106 comprising forming a top electrode 192 (col. 10, lines 39-62) of a capacitor with high-k material on a semiconductor substrate 110 by a chemical vapor deposition method in a sub-atmospheric pressure using an organoruthenium compound as a precursor (col. 7, lines 50-67 and FIG. 8), which includes steps of:

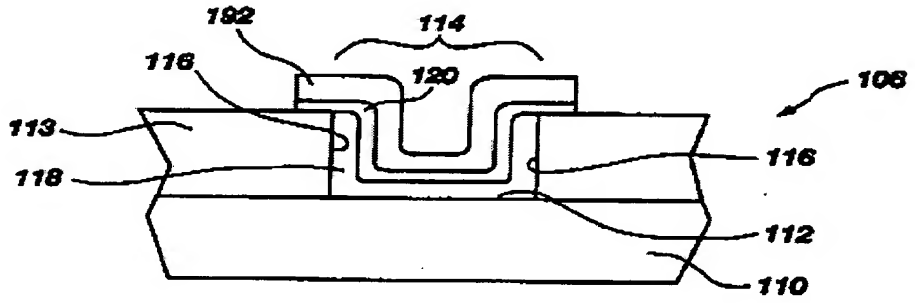

Fig. 8

providing the semiconductor substrate 110 in a deposition chamber;

increasing a temperature of the semiconductor substrate 110 in the chamber up to a desired temperature (col. 7, lines 50-60);

separately supplying the precursor and an oxidation gas into the deposition chamber to form a ruthenium film for the top electrode with a desired thickness on the heated semiconductor substrate, the oxidation gas being separately supplied to the deposition chamber by a supplying system different from a precursor supplying system (col. 7, line 50 to col. 8, line 61); and

stopping the supply of the precursor and the oxidation gas; and decreasing the temperature of the semiconductor substrate, wherein the top electrode essentially consists of ruthenium (col. 8, lines 23-46), and the oxidation gas is supplied to the deposition chamber when the substrate temperature is increased, when the precursor is supplied, and when the substrate temperature is decreased (col. 7, line 62 to col. 8, line 40).

In re claims 22 and 32, Marsh discloses wherein the ruthenium electrode forming method further includes a step of introducing a balance gas in addition to a carrier gas (Ar) so as to keep a pressure in the deposition chamber constant through all of the other steps (col. 8, lines 23-40),

In re claim 31, Marsh discloses that the oxidation gas comprises at least one of O_2, N_2O, H_2O, NO_2, and O_3 (col. 2, line 61 to col. 3, line 5).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 4-8, 10-15, 20, 23-30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Marsh et al. (U.S. Patent 6,461,909) in view of Won et al. (U.S. Pub. 2001/0006838) and Yang (U.S. Patent 6,617,248).

In re claims 4-8 and 23-28, Marsh does not explicitly disclose that the amount of oxygen adsorption onto the surface of the semiconductor substrate is set to a minimum amount required for de-composing the precursor thereby increasing the amount of

oxygen adsorption onto the surface of the semiconductor substrate and shortening a growth time of the electrode. However, the disclose process would obtain the recited results because the same materials are treated in the same manner as in the instant invention.

In re claim 10 and 29, Marsh does not explicitly disclose wherein the organoruthenium compound comprises at least one of bis-(ethylcyclopentadienyl) ruthenium [$Ru(C_2H_5C_5H_4)_2$], bis-(methylcyclopentadienyl)ruthenium [$Ru(CH_3C_5H_4)_2$], bis-ethylcyclopentadienyl)ruthenium [$Ru(C_2H_5C_5H_4)_2$], tris-(dipivaloylmethanate)ruthenium ($Ru(C_{11}H_{19}O_2)_3$], and Ru $(OD)_3$ as required in the claimed invention.

Won, however, discloses that the organoruthenium compound comprises bis-(ethylcyclopentadienyl) ruthenium [$Ru(C_2H_5C_5H_4)_2$] (pages 2-3, paragraph [0029]). It would have been obvious to one of ordinary skill in the art at the time of the invention was made to combine the teaching of Marsh and Won to enable the organoruthenium compound of Marsh to be formed and furthermore Ru films having improved continuity and reduced sheet resistance may be obtained (page 2, paragraph [0013], Won et al.).

In re claims 11 and 30, Won discloses that the solvent for dissolving the organoruthenium compound comprises tetrahydropuran (page 3, paragraph [0040]).

In re claim 12, Marsh does not explicitly disclose after forming the bottom electrode, immediately performing annealing at not less than a formation temperature of the bottom electrode made of ruthenium in a reducing atmosphere containing hydrogen thereby removing oxygen introduced into a surface of the ruthenium metal film when the

ruthenium metal film is formed thereform and inhibiting deformation of crystal grains of the bottom electrode of ruthenium in the annealing step during or after forming a high-k capacitor insulator.

Yang, however, discloses performing annealing at not less than a formation temperature of the electrode made of ruthenium (at between about 400 to 800° C) in a reducing atmosphere containing hydrogen thereby removing oxygen introduced into a surface of the ruthenium metal film when the ruthenium metal film is formed therefrom (col. 2, line 60 to col. 3, line 58) and inherently inhibiting deformation of crystal grains of the electrode of ruthenium in the annealing step during or after capacitor insulator formation. It would have been obvious to one of ordinary skill in the art at the time of the invention was made to combine the teaching of Marsh and Yang to enable the process of annealing the bottom electrode of ruthenium in a reducing atmosphere containing hydrogen of Marsh to be performed and furthermore to obtain a ruthenium metal layer having various degrees of smooth and rough textures (Abstract, Yang).

In re claims 13 and 20, Marsh discloses that the annealing temperature in the reducing atmosphere is not more than the annealing temperature for crystallization of the capacitor insulator (col. 8, lines 23-40).

In re claim 14, Marsh discloses that the temperature at which the deformation of crystal grains of the bottom electrode of ruthenium is inhibited is 800 °C or less (col. 8, line 23-40).

In re claim 15, Marsh does not explicitly disclose that an average grain size of the crystal grains of the bottom electrode of ruthenium is 30 nm to 60 nm. However, there is

no evidence indicating that the average grain size of the crystal grains of the bottom electrode of ruthenium is critical and it has been held that it is not inventive to discover the optimum or workable size or thickness of a result-effective variable within given prior art conditions by routine experimentation. See MPEP § 2144.05. Note that the specification contains no disclosure of either the critical nature of the claimed dimensions of any unexpected results arising there from. Where patentability is aid to be based upon particular chosen dimensions or upon another variable recited in a claim, the Applicant must show that the chosen dimensions are critical. In re Woodruff, 919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir. 1990).

Response to Applicant's Amendment and Arguments

Applicant's arguments with respect to claims 1, 3-8, 10-16 and 18-32 have been considered but are moot in view of the new ground(s) of rejection.

Applicants contend that neither Eguchi nor Yang, or their combination as relied upon teaches or suggests the features of Claim 1: supplying an oxidation gas separately from the supply of the precursor into a deposition chamber and only during the precursor-supplying step for forming a bottom electrode essentially consisting of ruthenium of a capacitor; or Claim 21: supplying an oxidation gas separately from the supply of the precursor into the deposition chamber and during the substrate temperature increasing and decreasing steps and the precursor-supplying step for forming a top electrode essentially consisting of ruthenium of a capacitor.

In response to Applicants' contention that neither Eguchi nor Yang teaches or suggests supplying an oxidation gas separately from the supply of the precursor into a

deposition chamber and only during the precursor-supplying step for forming a bottom electrode essentially consisting of ruthenium of a capacitor. Since Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action, Applicants are directed to pages 2-3 presented in this Office action where the newly discovered reference, Marsh et al. (U.S. Patent 6,461,909) discloses separately supplying the precursor and an oxidation gas into the deposition chamber to form a ruthenium film for the bottom electrode with a desired thickness on the heated semiconductor substrate, the oxidation gas being separately supplied to the deposition chamber by a supplying system different from a precursor supplying system and only during when the precursor being supplied (col. 7, line 50 to col. 8, line 61); and stopping the supply of the precursor and the oxidation gas; and decreasing the temperature of the semiconductor substrate, wherein the bottom electrode essentially consists of ruthenium (col. 8, lines 23-46).

For this reason, Examiner holds the rejection proper.

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a). A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any

extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Khiem D. Nguyen whose telephone number is (571) 272-1865. The examiner can normally be reached on Monday-Friday (8:30 AM - 5:30 PM).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached on (571) 272-1855. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

K.N.
March 18th, 2005

W. DAVID COLEMAN
PRIMARY EXAMINER